

MEASUREMENT OF SOME JAMAICAN HIGH SCHOOL STUDENTS' LEVELS OF ANXIETY TOWARDS SCIENCE¹

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Anxiety is one of the major psychological variables which interferes with students' learning and performance. One main purpose of this study, therefore, was to measure the levels of anxiety that some Jamaican high school students showed towards science. A second main purpose was to investigate the effects of variables such as grade level, gender, school location, number of science subjects the students were studying and their science subject preference on their levels of anxiety. A total of 313 (149 boys and 164 girls, comprising 133 grade 9 and 180 grade 11 students) from two rural and four urban high schools formed the study's sample. The Zuckerman Affect Adjective Checklist modified by Docking (1978) was the instrument used to measure the students' anxiety levels. The results showed that the students fell into three anxiety levels: low (10.86%), average (78.60%) and high (10.54%); rural school students were significantly more anxious than the urban ones; grade 11 students were slightly more anxious than the grade 9 students; the females were slightly more anxious than the males; students studying three science subjects were slightly more anxious than those studying two or one subject; students who preferred biology were slightly less anxious than those who preferred either physics or chemistry. The implications of the findings for science education are emphasized.

Introduction

Anxiety is one of the main psychological factors which affects pupils' learning and progress in school (Phillips, 1978). In the psychological literature, a distinction is normally made between normal and neurotic anxiety on the one hand, and between situational and trait anxiety on the

¹This article is a revised version of a paper presented at the 2nd Biennial Cross-Campus Conference on Education, UWI, St. Augustine, 22-24 April, 1992. The author thanks the reviewers for their comments which were extremely helpful in the revision process.

other. Normal anxiety is the apprehension that most people experience in certain situations. It often has a positive effect in making them cautious in performing cognitive tasks and considerate in their social relationship, because they need to be vigilant in order to succeed in both domains (Lindgren, 1976). This apprehension only becomes neurotic when the arousal is so intense that it deactivates higher mental processes, hinders decisive action and focuses on the discomfort experienced rather than the problem being confronted. Others, like Eysenck (1947) and Spielberger (1972), distinguish between situational anxiety or anxiety which occurs only in some clearly defined circumstances, such as when sitting an examination, and trait anxiety which appears to be a part of an individual's innate personality, so that the stimuli that provoke it are numerous and multifarious. Spielberger (1972) also perceives anxiety as an aversive or unpleasant state involving subjective apprehension and physiological arousal of a diffuse nature while Okebukola (1986) defines it as an experience of dread and foreboding based on some diffuse or specific expectation of harm rather than on an obvious external threat.

Anxiety has been shown to be one of the pressures that exerts immense influence on students' classroom functioning and achievement of important cognitive and affective domains (Fraser, Nash, & Fisher, 1983; Spielberger, 1966; Tobias, 1979). For example, Spielberger (1966) reported that highly anxious students performed well on simple learning tasks while the low anxiety ones excelled on more complex problems. Cameron (1982), however, found no significant relationship between school anxiety and the academic achievement of 131 grade 11 Jamaican students. McKnight (1985) also reported that test and general anxieties exerted no significant effects on the academic performance of 302 grade 11 Jamaican students. On the other hand, Soyibo (in press - a), using 124 grade 11 Jamaican students, reported that the less anxious students significantly outscored the highly anxious ones on a biology test. Furthermore, Okebukola & Jegede (1989) and Jegede, Alaiyemola, & Okebukola (1990) have demonstrated that the low anxiety students in their studies significantly outperformed their highly anxious counterparts in biology tests.

The Problem

Because many of the cited studies have emphasized the relationship between anxiety and academic achievement, anxiety towards science is an essential variable to investigate. For example, the Caribbean Examinations Council's (CXC) Chief Examiners' Reports (1986-1992) on candidates' performance in physics, chemistry and biology indicate that the candidates' performance was consistently low—with biology recording the highest enrolment but the poorest results. During this period, Jamaican candidates' enrolment and performance in these subjects were consistently the highest and poorest respectively in comparison with their counterparts from Trinidad and Tobago, and Barbados. Assuming that many of the factors likely to be responsible for this depressing situation (e.g., the dearth of qualified science teachers, inadequate science equipment, and high student:teacher ratio) are properly taken care of, it is necessary for Jamaican (and other Caribbean) science teachers to be aware of their students' levels of anxiety towards science. This knowledge may sensitize them to the need to create an anxiety-free atmosphere during science lessons which would be conducive to the promotion of effective science learning and achievement. This study, therefore, sets out to provide answers to the following questions:

1. What levels of anxiety do grades 9 and 11 Jamaican traditional high school students show towards science?
2. Do the students' grade level, gender, school location, number of science subjects being studied and science subject preference have any significant effects on their science anxiety?

In this study, science anxiety is defined as the uncomfortable feeling students experience when faced with or thinking of science, due to the expectation that something unpleasant will happen during their exposure to school science.

Method

Sample

A total of 313 students (149 boys and 164 girls comprising 133 grade 9 and 180 grade 11 students) randomly selected from two rural and four

urban traditional high schools in Jamaica formed the subjects of this study. All the students were studying at last one science subject in preparation for the CXC Secondary Education Certificate Examination (SECE). Students in the selected schools made their SECE subject selection in grade 9. 'Traditional high school' in this study means a post-primary school that prepares students solely for the academic ('grammar type') subjects examined by the CXC at the end of a 5-year secondary education. A 'rural' school in this study is one situated in a place that is not readily accessible by motor vehicles; many of the residents are skilled workers, (e.g., masons, carpenters); some of the residents are peasant farmers and there are no basic infrastructural facilities such as a post office and police station. Most students have to walk long distances to attend such a school. An urban school is one situated in a city, such as Kingston, which is readily accessible by road and enjoys all the basic infrastructural facilities typical of a city and which are normally absent in a rural school.

Instrumentation

The students' anxiety towards science was measured using a version of Zuckerman's (1960) Affect Adjective Checklist which contained the modifications made by Docking (1978). This self-report instrument consists of 21 key words embedded in the total list of 60 adjectives arranged in alphabetical order (See Section B of Appendix A). The students were instructed to underline as many or as few of the words which described how they felt about learning science. The 11 words designated (+) were scored 1 if they were underlined and 0 if they were not underlined. The 10 words designated (-) were scored 0 if they were underlined and 1 if they were not underlined. The remaining 39 words were ignored in the scoring procedure in line with the instrument's scoring protocol (Docking, 1978; Docking & Thornton 1979; Fraser et al., 1983). Each student's total anxiety score was obtained by adding up the scores on the 21 key words. The possible range of scores is 0-21. A high score denotes high anxiety and a low score denotes the converse. The instrument was administered to the students towards the end of the first term of the 1991/1992 school year. The KR-20 internal consistency reliability coefficient of the instrument was calculated to be 0.73 for this study's sample. This value is high enough to recommend future use of the instrument to measure the anxiety of individual students to science.

Attempts were made to establish the degree of validity of the instrument in the local context. First, copies of the instrument were given to three university lecturers in educational psychology, test and measurement, and science education respectively. They were requested to assess its content validity by indicating whether: (1) the 11 words designated (+) really tapped the parameters of anxiety; (2) the 10 words designated (-) were appropriate opposites of the former, and (3) the remaining 39 words could assess anxiety and non-anxious behaviours. There was total agreement among them that the 21 key words were appropriate and could validly measure the domain of science anxiety as operationalized for this study. There was about 87% agreement among them that the remaining words could really measure anxiety.

A pilot study was done to ascertain the extent to which the subjects could understand the meanings of the words. Thirty four grade 9 student volunteers (19 from an urban high school, 15 from a rural high school) were asked to write down the meanings of the words. It took about an hour for the slowest student to finish. Their responses were scored by the researcher. It was discovered that 27 (80%) of the students (16 urban, 11 rural) understood the meanings of the 21 key words, but only 22 (64%) understood the meanings of all the words. Based on the foregoing findings, the instrument could be considered as generally valid and relevant in the Jamaican context. Because many of the pilot grade 9 students understood the meanings of most of the words, it was assumed that many of the grade 9 students sampled, and most of the grade 11 students sampled, would be able to understand their meanings. However, the instrument has a few limitations, two of which are noted in the last section of this paper.

The instrument was found to have a good concurrent validity (with correlations of 0.62 to 0.74 with other measures of anxiety such as personality and achievement) and good reliability (test-retest coefficient of 0.83) (Fraser et al., 1983). In addition to the above features, the instrument was considered suitable for use in a Jamaican context for a number of reasons. It can be answered easily and quickly by students; it can be scored easily. Another main reason for adopting the instrument for this study was that Soyibo (in press - a), using the same instrument, discovered that about 11%, 78% and 11% of the 124 Jamaican grade 11 students he sampled displayed low, average and high anxiety respectively towards science. This finding was very similar to the one recorded in

this study and, hence, further confirms the consistency of the instrument used in this study and its suitability for use in a Jamaican context.

The Jamaican School Anxiety Scale (JSAS) developed by Cameron (1982) was found unsuitable for this study because it focused mainly on school anxiety and was developed from three scales by Boxall (1961), Eysenck & Wilson (1975) and Herrenkhol (1972), the contents of which do not specifically deal with anxiety towards science or any other school subject. It was for similar reasons that McKnight (1985) found Cameron's JSAS unsuitable for his study. Again, the general anxiety scale (developed by Persaud) and the test anxiety scale developed by Herrenkhol (1972) which McKnight (1985) used, were considered unsuitable for this study because they were not designed to measure science anxiety or anxiety towards any specific school subject. In short, the anxiety instruments utilized by Cameron and McKnight appear to be comparatively lengthy, and too restrictive in focus to be of use for this study.

Results

The students were categorized into various anxiety levels after calculating individual anxiety level scores. The sample mean and standard deviation were found to be 9.42 and 3.41 respectively. The students who scored between 1 and 5 (1 - 2 SDs below the sample mean) were categorized as exhibiting 'low' anxiety towards science. The students who scored between 6 and 13 (1 SD below or above the mean) were classified as displaying 'average' anxiety, while those who scored 14 to 20 (1 - 3 SDs above the mean) were grouped as showing 'high' anxiety towards science. This classification, together with the frequency data and percentages, is displayed in Table 1.

Table 1
Classification of Students Showing Frequency
and Percentage Distribution of Scores

Scores	Distance from sample mean	Category	Frequency	%
1-5	1-2 SDs below the mean	Low	34	10.86
6-13	Within + or - 1 SD from mean	Average	246	78.60
14-20	1-3 SDs above the mean	High	33	10.54

N = 313 Mean = 9.42 SD = 3.41

The data in Table 1 signify that the students' anxiety scores ranged from 1 to 20 and seem to follow the normal distribution curve, with the students falling into three levels of anxiety: low (10.86%), average (78.60%) and high (10.54%). Although students suffering from neurotic anxiety are likely to obtain high scores on the science anxiety instrument, a high score per se should not be perceived as pathological because students with normal patterns of anxiety often reach a high level of arousal in response to powerful stimuli such as certain school situations and tests. At any rate, the cardinal purpose of this study was not to identify potentially psychologically ill science students.

To determine the possible effects of some factors such as grade level, gender and school location on the students' anxiety towards science, the t-tests carried out on their paired mean scores are summarized in Table 2.

Table 2

T-Tests of Difference in Students' Mean Scores

Variables	n	Mean	SD	t
Grade 9 students	133	9.12	3.80	1.28
Grade 11 students	180	9.63	3.00	
All boys	149	9.38	3.21	0.32
All girls	164	9.50	3.41	
Rural students	119	9.97	3.28	*2.03
Urban students	194	9.18	3.28	
Grade 9 boys	60	8.97	3.51	0.42
Grade 9 girls	73	9.25	4.05	
Grade 11 boys	89	9.55	2.89	0.33
Grade 11 girls	91	9.70	3.37	

* $p < .05$.

Table 2 suggests that the mean anxiety level of the students in the rural schools was statistically significantly higher than that of their urban counterparts. Again, the table indicates that there were no significant differences in the students' levels of anxiety attributable to their grade levels and gender.

Tables 3 and 4 display the means and standard deviations of the students' anxiety scores based on the number of science subjects they were studying and their science subject preference. A one-way analysis of variance (ANOVA) conducted on the students scores to establish the possible impacts of the number of subjects being studied on anxiety levels ($F 2, 310 = 1.55$ $p > .05$) did not attain significance (Table 3). Similarly, a one-way ANOVA conducted to determine the possible effects of the students' subject preference on their anxiety levels ($F 2, 310 = 1.08$ $p > .05$) did not attain significance (Table 4).

Table 3

Means, Standard Deviations and F-Test
Comparing Students' Anxiety Levels Based on the
Number of Science Subjects Studied

Number of science subjects studied	n	Mean	SD	F
1	57	9.49	2.62	
2	109	9.84	3.84	1.55
3	147	9.11	3.29	

Table 4

Means, Standard Deviations and F-Test Comparing Students'
Anxiety Levels Based on Their Science Subject Preference

Science subject preferred	n	Mean	SD	F
Biology	146	9.08	3.14	
Chemistry	69	10.00	3.16	1.08
Physics	98	9.64	3.35	

Discussion of Results

This study's first objective was to measure the levels of anxiety towards science exhibited by some Jamaican high school students. The results obtained seem to suggest that the students sampled fell into three levels of anxiety—low (10.86%), average (78.60%) and high (10.54%). (See Table 1). This finding is in accord with the finding of Richardson (1983) in respect of pre- and post-O'Level Jamaican students' anxiety towards

school as well as Soyibo's (in press - a) finding regarding grade 11 Jamaican students' anxiety levels towards science.

The second purpose of this study was to investigate whether factors such as grade level, gender, school location, the number of science subjects being studied and science subject preference had any significant effects on the students' levels of anxiety. Evident in Table 2 is the finding that only the students in the rural schools were significantly more anxious than their urban counterparts. This finding receives some support from Soyibo's (in press - c) finding that 186 rural grade 7 Jamaican students were significantly more anxious towards science and, hence, performed significantly worse on a test of science process skills than their 216 urban counterparts who were significantly less anxious. This present study's finding, however, contradicts that of Soyibo (in press - a) who reported that urban Jamaican grade 11 students who were slightly more anxious towards science than their rural counterparts, performed significantly worse on a biology test. On the other hand, the finding of McKnight (1985) that rural Jamaican grade 11 students were significantly "generally" more anxious than their urban counterparts lends credence to this study's finding.

McKnight (1985, p. 157) attributed the significantly higher mean general anxiety score of the rural students in his study to the pressures which they encountered in their small communities, as well as from their parents who had lower socio-economic status than the parents of their urban counterparts. In addition, he posited that the rural students' urban peers might consider life to be more secure because of their parents' material possessions and their 'freer urban environments.' These reasons, which are likely to hold true for this study's students and finding, were supported by P.N. Whiteley's (personal communication, Jan. 4, 1992) similar explanation for its finding. According to him, many rural parents in Jamaica are likely to put intense pressure on their children to perform well in science or school because, to them, this is the only way of getting them out of the cycle of poverty typical of the rural areas.

Moreover, the physical environment of the rural high school, its track record, and so forth, could be generally more stressful to the rural students when compared with their urban counterparts. According to McKnight (1985, p. 153), the higher general anxiety of rural students might result from the greater pressures experienced in everyday living

compared with the relative ease in daily living experienced by their urban peers who enjoy a higher socio-economic status. The shortage of qualified science teachers and science equipment—which is widespread in many Caribbean high schools (King, 1990)—is likely to be more acute in rural high schools than in urban ones. All these factors are possible sources of the significantly higher anxiety level to science exhibited by the rural students in this study relative to their urban peers.

Table 2 data also indicate that: (1) grade 11 students were slightly more anxious than grade 9 students, and (2) females were slightly more anxious than males. While Table 3 data suggest that students who were studying three science disciplines were slightly less anxious than those studying either one or two science disciplines, Table 4 indicates that the students for whom biology was a favourite subject were slightly less anxious than those for whom either chemistry or physics was a favourite. In reality, these slight difference might have been simply due to chance.

Conclusions and Implications

This study reveals that the sampled students exhibited three levels of anxiety towards science: low, average and high; the rural students were significantly more anxious than their urban peers while the females were slightly more anxious than the males. Anxiety is an experience of dread and expectation of harm which has been found to impede several personality functions (Okebukola, 1986) as well as exerting considerable influence on learners' intellectual competence and performance (Baird 1986; Okebukola & Jegede, 1989; Soyibo (in press - a; -c). It is, therefore, necessary to undertake empirical studies aimed at reducing Jamaican high school students' anxiety towards science. There may also be a need to look closely at what environmental variables—both in and out of science classrooms—contribute to raising the levels of students' anxiety towards science, especially the females. To enhance the generalizability of the findings from this study, it is suggested that future studies should use larger sample sizes.

The students in the rural schools were significantly more anxious than their urban counterparts. It is, therefore, suggested that science teachers in rural (as well as in urban) schools should create an anxiety-free learning environment which would help to lessen their students' anxiety

and facilitate the effective teaching and learning of science. To be able to reduce the slightly higher anxiety level of the female students towards science, science teachers should deliberately pay more attention to their needs, without neglecting the needs of the male students, especially in coeducational schools. This is because research evidence indicates that many teachers unconsciously tend to attend more closely to the needs of male students in mixed science classes which the males often dominate (Forrest, 1992; Kelly, 1985).

Limitations

Some research evidence suggests that the performance of girls in science is influenced by the type of school they attend. Forrest (1992, p.116) reports that girls' schools achieve better science examination results than boys' schools. School type may thus affect students' levels of anxiety towards science. This possibility was not explored in this study. Future studies in this area should, therefore, investigate the main and interaction effects of school type (e.g., single-sex versus coeducational school) and other relevant mediating variables on students' anxiety towards science.

Students' perceptions of certain features of their actual science environment have been shown to influence their level of anxiety towards science. For example, lower levels of student anxiety were found in science classrooms perceived by students to be characterized by greater 'personalization' (teachers' helpfulness to students), 'participation' (students' input in class work/discussion) and by less 'teacher control' (Fraser et al., 1983). These and many other characteristics of the science classroom environment which could provide guidance about how science teachers might change their classroom practices (e.g., in terms of increased student participation and decreased teacher control), in an attempt to alleviate the undesirable impacts of student science anxiety, were not explored in this study. Such issues need to be addressed in future studies. It would be interesting to find out if there is any high positive correlations among Jamaican grades 9 and 11 students' science anxiety levels and their perceptions of the following characteristics of their actual science classroom environment: participation, personalization, investigation, independence (students' control over their work) and differentiation (students' freedom to work at their own pace) because

they were highly favourably perceived in the above order by 426 grades 9 and 11 Jamaican high school students (Soyibo, in press - b).

Two of the limitations of the instrument used in this study are that: (1) the length of the list of words could discourage some students from reading through every word, and (2) the students were instructed to underline as many or as few words as possible. This might encourage some students to underline only a few words. However, in this study the least number of words underlined was 15 and the highest was 31. For future studies, it is suggested that the instrument should be adapted. This should entail using only the 21 key words. Each of them should be expressed in a full statement (positive or negative). Each statement should be provided with a 5-option Likert-type responses (from "strongly agree" to "strongly disagree") and scored appropriately.

Appendix A Science Anxiety Questionnaire

Section A

School.....Grade.....Male or Female.....Age.....

Underline any of these subjects which you now study in school:

Physics

Chemistry

Biology

Which of the following subjects do you like best?

Underline it. Physics

Chemistry

Biology

Section B

Zuckerman's Affect Adjective Checklist as Modified by Docking (1978)

Instructions

The words below could describe how you feel about school science. Read through the list of words and underline those which describe how you generally feel about science. You may underline as many or as a few words as you wish.

absorbed	afraid(+)	aimless	ambitious	annoyed
aware	bored	calm(-)	careless	cautious
challenged	cheerful(-)	cheated	comfortable	confused
contented(-)	creative	curious	dedicated	desperate(+)
disappointed	efficient	entertained	excited	fearful(+)
fortunate	frightened(+)	happy(-)	hopeless	impatient
incapable	inspired	interested	joyful(-)	lazy
loving(-)	miserable	misplaced	nervous(+)	organized
overloaded	panicky(+)	pleasant(-)	pleased	productive
pushed	refreshed	regretful	rewarded	satisfied
secure(-)	serious	shaky(+)	steady(-)	tense(+)
terrified(+)	thoughtful(-)	upset(+)	weary	worried(+)

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